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PHOTOIONIZATION CROSS SECTIONS FOR C⁻, N AND O⁺

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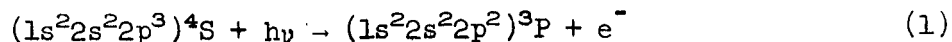
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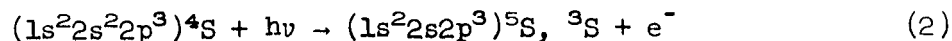
Photoionization cross sections for N and O^+ for energies < 10 ryd., and for C^- for energies < 5 ryd., are calculated using the Hartree-Fock approximation for the final states of transitions involving the ejection of an electron from the configuration $1s^2 2s^2 2p^3(^4S)$.

AUTHOR

The transitions with which we are concerned may be described by



and



for the ejection of an outer or inner shell electron respectively.

The Hartree-Fock approximation [1] is used for the final states of a transition given by equations (1) or (2). Analytic representations of the Hartree-Fock wave functions were employed for the core orbitals. Those for $C^-(^4S)$ and $C^-(^3P)$ were supplied by Dr. P. Kelly of Lockheed Missiles and Space Corporation, and for $N, O^+ (^4S)$, and $N^+, O^{++} (^3P, ^5S, ^3S)$ we used those obtained by Roothaan and Kelly [2].

The photo detachment cross sections for the transition (1) for C^- and the photoionization cross sections for the sum of processes (1) and (2) for N and O^+ are shown in figure 1. Curves A and B correspond to the dipole length (σ_{DL}) and dipole velocity (σ_{DV}) formulations respectively for the different systems.

Curve D represents the results of Cooper and Martin [3] for C^- . They used a modified Klein-Brueckner model [4] and the dipole length cross sections they obtained are in good accord with those presented here. The cross sections are of the correct order of magnitude but display an incorrect energy variation near threshold when compared with the experimental results of Seman and Branscomb [5].

Myerscough and McDowell [6] attempted to improve the theoretical cross sections near threshold by adding a polarization potential to the direct potential. Their results, which neglect exchange, improved the cross sections calculated in the dipole length approximation but their dipole velocity results were greatly reduced thus enhancing the discrepancy between the two formalisms. We hope to present in the near future results of calculations which explicitly take into account both direct and exchange polarization terms.

Curve E shows the results of Bates and Seaton [7] for atomic nitrogen. They used bound wave functions calculated by Hartree and Hartree [8] in conjunction with wave functions obtained from the oxygen core for the ejected electron. This yielded for the absorption cross section at the spectral head the values 10.2 and 7.7 Mb for σ_{DL} and σ_{DV} respectively. They adopted the mean of these values and computed the energy variation of the cross sections using an approximate general formula due to Bates [9].

Absorption cross sections for atomic nitrogen have been measured by Ehler and Weissler [10]. The maximum value of $\sigma_{DL} = 12.4$ Mb at 650 \AA compares

favorably with the maximum value of $\sigma = 14.4$ Mb. derived from the experiments at the same wave length. The experimental and theoretical cross sections have the same general shape.

A useful guide to the L_1 - absorption cross sections can be obtained by assuming that $\sigma(N) = \frac{1}{2} \sigma(N_2)$. The experimental values for $\frac{1}{2} \sigma(N_2)$ of Samson and Cairns [11] are represented by crosses on figure 1. It can be seen that the dipole length formalism is in better agreement with the experimental values than the dipole velocity formalism for intermediate energies.

In contrast to the results of Dalgarno and Parkinson [12] for atomic nitrogen, there is only a slight discontinuity at the L_1 - absorption edges corresponding to final states $N^+(^5S)$ and $N^+(^3S)$, at 608\AA and 367\AA respectively.

Curve F shows the results of Bates [9] for the singly ionized oxygen, who used an approximate formula for the dipole length matrix element. Burgess and Seaton [13] have computed cross sections using the quantum defect method, and their spectral head cross section of 8.0 Mb. lies within the present computed values, however, their cross sections fall off more rapidly with energy than those calculated by the Hartree-Fock approximation.

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Legend:

FIG. I. Cross sections, σ , in megabarns for C^- , N and O^+ .

Curves A and B are $\sigma_{D.L.}$ and $\sigma_{D.V.}$ respectively for the present calculation.

Curve D - Cooper and Martin [3].

Curve E - Bates and Seaton [7].

Curve F - Bates [9].

x - $\frac{1}{2} \sigma(N_2)$ from Samson and Cairns [11].

